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(54) Title of the Invention: Fine-Particle Steel Shot and a Method for Its Manufacture

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Specification

1. Title of the Invention

Fine-Particle Steel Shot and a Method for Its Manufacture

2. Claims

1. A method for the manufacture of fine-particle steel shot characterized in that white iron pyrite is melted at 1300°C to 1400°C by means of a cupola furnace and granulation treatment is performed by the granulation into-water method, after which it is dried and sieved, the cast iron granular matter containing 2 to 4% of carbon and of a particle diameter of 0.1 to 2.0 mm that is obtained being subjected to a decarbonizing treatment for 0.5 to 10 hours using a stirring or agitating device in a heating furnace maintained at 800°C to 1000°C with the atmosphere inside the furnace being controlled as oxygen or a gas containing oxygen is forcibly fed, by which means the carbon content of the granular matter is greatly decreased, with the surface content being greatly decreased by comparison to the interior.

2. A method for the manufacture of fine-particle steel shot as described in claim 1, further characterized in that the vessel which contains the cast iron granular matter is introduced into a heating furnace, the vessel is rotated as oxygen or air is forcibly introduced into the vessel under pressure and in that it serves as the stirring device for the granular matter.

3. A fine-particle steel shot, further characterized in that it is manufactured by the method of manufacture described in claims 1 and 2, in that

the carbon content of the granular matter of particle diameter 0.1 to 2.0 mm is in the range of 0.1 to 1.0% and in that the surface content is greatly decreased by comparison to the interior.

3. Detailed Description of the Invention

(Field of Industrial Application)

This invention relates to a method for the manufacture of fine-particle steel shot that is used in shot peening processing from cast iron granular material and to the fine-particle steel shot that is manufactured.

(Prior Art)

Fine-particle steel shot comprised of steel granular matter, cut wire shot manufactured by cutting white iron pyrites comprised of cast iron granular matter and other steel wire into short segments and zinc shot can be selected for shot that is used in shot peening processing in accordance with the objective of processing.

Of these, the conventional method of manufacturing fine-particle steel shot, as shown in Figure 1 (b), is a method in which steel granular matter is obtained by heating and melting material scraps at 1550°C to 1650°C by means of an electric furnace, performing steel smelting, adjusting the carbon content to 0.5 to 1.0% and performing granulation treatment at normal temperature by the atomization-into-water method, with steel granular matter of a particle diamter of

0.1 to 5.0 mm being obtained, the product then being dried and sieved to a particle diameter of 0.1 to 1.0 mm, quenched at 800°C in a heat treatment process and tempered at 500°C to 600°C, with the fine-particle steel shot being manufactured.

(Problems the invention is intended to solve)

In the case of fine-particle steel shot manufactured as described above that is used for cleaning the surfaces of metals or for making coarse surfaces (matte surfaces), it is comparatively difficult to manufacture fine-particle steel shot that is used to remove rust and the cost of material comprised of hard particles is particularly high. The cast iron white pyrite shot that is used in addition to the former is manufactured by melting white iron pyrite material and scraps with a cupola [furnace] and subjecting them to granulation treatment, after which a heat treatment is performed and they are manufactured as fine-particle iron shot. Problems in the quality of steel fine-particle shot include the occurrence of shrink marks and cracks on the surface of the granular material and deterioration of sphericity. There is also the drawback of low durability.

This invention was developed in the light of the aforementioned problems. Its objective is to develop and provide a method for the manufacture of fine particle steel shot in which the manufacturing process is simple, which is highly economical and whereby the aforementioned problems of quality do not occur.

(Problems the Invention Is Intended to Solve)

This invention, which is for the purpose of achieving the aforementioned objective, relates to an improved method of manufacture for obtaining fine particle steel shot in which, by the manufacturing method for white iron pyrite shot, white iron pyrites are melted at 1300°C to 1400°C by cupola and in which, up to the granulation treatment by the atomization-into-water method and drying and sieving treatments, the cast iron granular matter with a carbon content of 2 to 4% is subjected to a decarbonizing treatment in which the heating furnace is maintained at 800°C to 1000°C in a controlled atmosphere into which oxygen is introduced under pressure instead of performing sintering as a heat treatment, with the carbon content in the fine-article steel shot being reduced and steel granular matter being formed in which there is a much lower distribution on the surface of the granular matter than in the interior. In this heating process, the granular matter in the heating furnace is sintered as the temperature increases, for which reason it is necessary that the temperature be set below 1000°C. Moreover, it is necessary to carry out the heat treatment while providing constant stirring or agitation in order to prevent sintering. For this reason, the granular matter is introduced into a container which is placed in the heating furnace and the decarbonizing treatment is carried out for the specified treatment time as the container is being rotated.

(Action)

By means of the method of manufacture of this invention, a method whereby fine-particle steel shot can be obtained without the problems of conventional steel shot and that allows for far more economical manufacture is provided.

Specifically, in the conventional method, there is a process in which, first, scraps, which are maintained at a high temperature for each shot, are melted by electric furnace melting and in which steel smelting is performed. In this method, the white iron pyrites are melted by a continuous process at a low melting temperature using a cupola [furnace], for which reason the required energy resources are decreased and the use of refractory brick is also decreased. In addition, when heat treatment is performed in the final process, in the conventional method, quenching and tempering are performed and fine-particle steel shot having similar hardness on the surface and in the interior of the granular matter is obtained. However, in terms of the quality of the product, shrink marks and cracks occur and there is poor sphericity. By contrast, in the atmosphere-controlled heat treatment of this method, decarbonizing treatment is performed and fine-particle steel sheet is obtained, for which reason, the manufacturing process is simple and is competed at low cost with the result that it is far more economical, that there are no shrink marks or cracks on the granular material that is obtained, that it is of good sphericity, that the surface is of a low carbon content and that fine-particle steel shot of high durability is obtained, the surface of which has a low carbon content and is tough and which

has a region in the interior of high hardness in which there is a high carbon content.

(Examples)

We shall now present a detailed description of this invention using examples and figures. However, this invention is not limited to them.

Figure 1 is a block diagram for the purpose of illustrating the method of manufacture of the fine-particle steel shot of this invention by comparison to the conventional method. Figure (a) is the method of manufacture of this invention in which, when white iron pyrite material is necessary, scraps are melted at 1300°C to 1400°C by the cupola [furnace]. The carbon content of the white iron pyrites is 3 to 4%. Next, a granulation treatment is performed by the atomization-into-water method by a standard method, a cast iron granular material of a particle diameter of 0.1 to 5.0 mm is obtained and the material is made to a finer particle diameter of 0.1 to 2.0 mm in the drying and sieving processes. Next, in the atmosphere-controlled heat treatment process, decarboxylation treatment is performed as the heating furnace is maintained at 800°C to 1000°C. In this case, as shown in Figure 3, the container 1, as shown in Figure 2, which can house the cast iron granular material, is introduced into the heating furnace 2 on the guide rail 3, which can be attached and detached freely, oxygen or a gas containing oxygen (usually, air) is introduced under pressure from the gas feed aperture 6, which is installed on the axis of rotation 5

of attachment 4 of container 1, and is supplied to the interior 9 of container 1 via the gas feed 8 of the refractory brick 7 that is installed in the inlet of container 1. The cast iron granular matter is placed in the high temperature zone of the oxygen atmosphere and the decarboxylation reaction indicated below occurs due to the carbon C and the oxygen O_2 in the cast iron.

$$C + O_2 = CO_2 \qquad (1)$$

$$CO_2 + C = 2CO \qquad (2)$$

The C in the cast iron decreases over time and a supply of oxygen is necessary in order to promote this reaction. On the other hand, decarbonizing proceeds over time and its rate is determined by the CO/CO_2 ratio, which is the atmosphere in the furnace. Therefore, decarboxylation time is determined by this ratio. Decarbonizing speed is also determined by temperature and there is a high diffusion coefficient for C in the interior of the granular matter when the temperature is over 800°C, for which reason a temperature higher than this is advantageous. Because the granular matter undergoes sintering as temperature increases, a temperature less than 1000°C is suitable. Further, because it is necessary to provide continuous stirring or agitation in order to prevent sintering, in this example, a device for rotation of container 1 was devised as shown by the arrow in Figure 2.

The axis of rotation is caused to rotate by the drive device shown in Figure 3.

The steel granular matter that is obtained in this way and which has particle diameters of 0.1 to 2.0 mm and a carbon content of 0.1 to 1.0% is molded to a region of low carbon (0.1%) on the surface and a region of high carbon (1.0%) in the interior. The pearlite texture hardness Hv on the surface becomes approximately 200 and the precipitated cementite texture hardness Hv in the interior becomes approximately 450, it is difficult to fracture the surface and the interior is hard, for which reasons a material of high durability is obtained.

Table 1 shows the findings of comparison tests of the steel shot obtained by the method of this invention and of conventional steel shot under various conditions of particle size of the fine particles, decarbonizing treatment temperature, quantity of air introduced under pressure, decarbonizing time and the number of rotations of the container. A durability greater than that found with the conventional method is indicated by the symbol O and a durability less than that is indicated by the symbol ×. Durability was assessed by comparing the 50% residual weight remaining when sieving to 250 μm after 3000 shot blasts.

No.	Particle size (diameter)	Temperature	Air pressure	Time	Number of rotations	Life
1	500-590μ	950°C	7.5 l/mm	3 H	13 ppm	O
2	"	1000	"	0.5	"	O
3	"	800	"	10	"	O
4	"-	700	"	10	"	X
5	"	1050	"	0.5	"	X
6	2500	900	"	3	"	X
7	2000	1000	"	"	"	O

Table 1

Figure 4 contains comparison examples of the lifetime curve of fine-particle steel shot obtained by the conventional method as shown by the dotted line and the lifetime curve of shot obtained by the method of this invention as shown by the solid line, with frequency of projections [blasts] on the horizontal axis and the residual amount of shot of particle diameters greater than 250 μm on the vertical axis. The steel shot of this invention exhibited a residual amount far superior to that of the conventional material after the projection frequency exceeds 1200 times. In this case, the decarbonizing treatment conditions of the shot of this invention were 950°C, 3 h, particle diameter of 500 to 590 μm and Hv = 182.

Finally, no difference was found in the scanning test (projection frequency, 5 times; 100 g weight/time) of the conventional fine-particle steel shot.

(Effect of the Invention)

Because this invention has the structure described above, there are the following advantages.

(1) As a result of manufacturing the fine-particle steel shot by decarbonizing treatment of cast iron granular matter, fine-particle steel shot comprised of steel granular matter can easily be obtained by a simpler process and far more economically than by conventional methods.

(2) As a result of the fact that the cast iron granular material is housed in the container that is used in this method of manufacture and the container is

introduced into a furnace after which the container is stirred by rotating, stopping of sintering in the decarbonizing treatment process of the granular product is assured and can be effected easily.

(3) The fine-particle steel shot that is obtained by the method of this invention is formed so that the carbon content is considerably lower on the surface than in the interior, its surface is difficult to fracture and the interior is hard, for which reason a shot of high durability is obtained and a fine-particle shot in which shrink marks and cracks do not occur in the granular matter itself, of which there are good yields, can be formed.

4. Brief Explanation of the Figures

Figure 1 is a block diagram of the method of manufacture of an example of this invention, in which figure (a) shows the manufacturing process of this invention and (b) shows the conventional manufacturing process; Figure 2 is cross-sectional view illustrating the essential component of the container; Figure 3 is an explanatory diagram of the arrangement of the essential components of the container for stirring that is used in the decarbonizing treatment of this method of manufacture; and Figure 4 is an explanatory diagram comparing the durability of the fine-particle steel shots.

(Explanation of the Symbols for the Principal Components)

1 – container

2 – heating furnace

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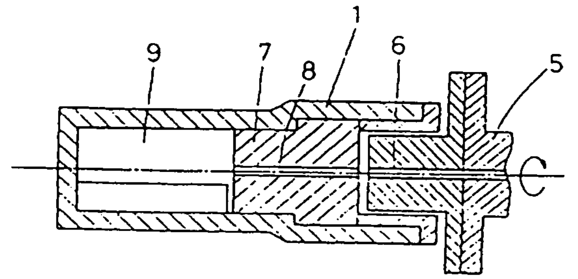
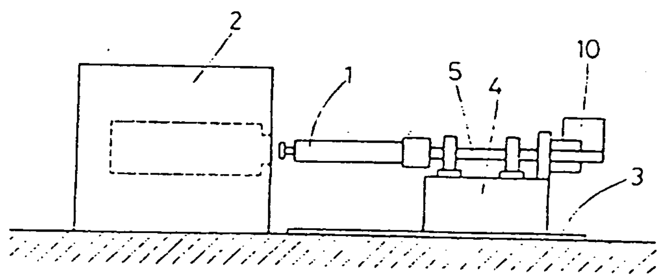
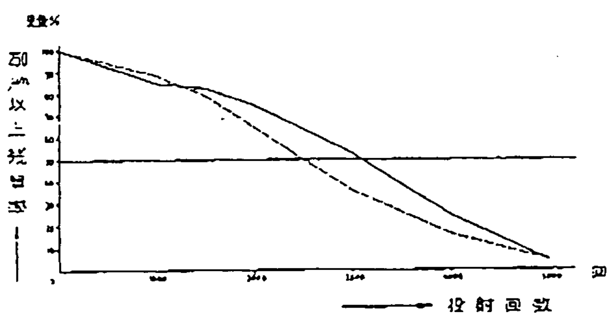


第 2 図



第 3 図



第 4 図

[top left]: weight %
y-axis: amount of particle diamters above 250 μm
x-axis: Projection frequency
[at end of horizontal axis]: times

(a) Scrap melting cupola —— Granulation treatment —— atomization-into-water method —— Drying and sieving —— Controlled atmosphere heat treatment —— Fine-particle steel shot

(b) Scrap melting electric heater —— Steel refining —— Granulation treatment —— Atomization-into-water method —— Drying and sieving —— Heat treatment —— Fine-particle steel shot

Figure 1

Figure 4